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Logistics Decision Support Tool (LDST) Framework and Design Concepts

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This technical report has been reviewed and is approved for publication.

FOR THE COMMANDER

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This report documents the results of research activities associated with the development of a framework for the Logistics Decision Support Tool (LDST). The specific research activities conducted as part of this effort included: 1) identifying deficiencies and shortfalls associated with current processes used to develop logistics support concepts for space systems, 2) specifying LDST functional requirements to help address these deficiencies and shortfalls, 3) performing a survey of current logistics support tools and software technologies that can be leveraged-on to address LDST requirements, 4) estimating a return on investment for LDST, and 5) development of design concepts to demonstrate the core functions of the LDST.

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PREFACE

This research was accomplished as part of the "Space Logistics Front-End Analysis" task order under the Technology Readiness and Sustainment (TRS) contract (F33615-99-D-6001). The period of performance for this task order spanned from April 2000 through January 2002.

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Executive Summary

This research was accomplished as part of the "Space Logistics Front-End Analysis" task order under the Technology Readiness and Sustainment (TRS) contract (F33615-99-D-6001). The period of performance for this task order spanned from 3 April 2000 through 31 January 2002.

The purpose of this task was to develop the framework for an automated Logistics Decision Support Tool (LDST) to help logistics managers and stakeholders conduct timely, accurate, and defendable logistics supportability analyses for space systems. The primary goals of the LDST task included: 1) identifying LDST core functional requirements 2) performing a survey of current logistics analysis tools related to LDST 3) identifying potential technologies for LDST, 4) specifying alternative design concepts for LDST 5) estimating a return on investment for the proposed LDST design concept, and 6) developing a high level, conceptual demonstration to highlight the core functions of the proposed LDST design concept.

During this task, meetings and discussions were conducted with SMC and HQ AFSPC personnel to help formulate the problem statement, scope, and key requirements for LDST. These interviews were supplemented by research of current DoD and AF acquisition policies and guidance related to the LDST problem domain. Based on these efforts, the following requirements were defined and used as a baseline for development of the LDST concepts presented in this report:

- The LDST should assist logistics managers in developing and evaluating logistics support concepts for space systems segments. A logistics support concept, as defined for LDST, applies to a specific ILS element area (e.g. Technical Data) and includes: 1) a recommendation on the specific products and services required to support a space system segment, and 2) a source (organic, contractor, or mix) recommendation for acquiring support products and/or performing support services (e.g. in-house or contractor training).
- The LDST should assist logistics managers (particularly novice managers) in developing logistics support concepts using a structured decision process that

allows for a rigorous analysis of the key decision factors, tasks, and criteria (e.g. system requirements, program and technical risks, and other pertinent factors) that impact logistics product/service, and source recommendations.

Based on these initial requirements, a follow-on literature search and survey of applicable software technologies and tools was performed to identify those that could address one or more of the LDST requirements. Most of the technologies applicable to the LDST fall under the umbrella of artificial intelligence, particularly knowledge-based or expert systems. In addition to a review of technologies, an in-depth review of current acquisition support tools was also conducted to determine which existing systems or tools contained features applicable to the LDST requirements.

This report addressed three alternative design concepts for LDST, including an *"LDST Support Analysis Checklist, "LDST Support Analysis Project Templates"*, and a *"LDST Support Concept Generator"*. Each of these concepts would involve varying levels of complexity, as well as time and effort, to implement as a production system or application. The proposed concept for LDST that best addresses the requirements outlined above is the *"LDST Support Analysis Project Templates"* concept that would leverage the knowledge of logistics domain "experts", as well as expert-based systems technologies, to provide a tool that can assist logistics managers (particularly novice managers) in identifying and addressing the specific tasks and decision factors they need to consider as part of a supportability analysis, based on program and system requirements for their respective programs. Logistics domain experts would create and maintain the business logic ("rules") defining and applying logistics support analysis task and decision factor templates to a program (a.k.a. LDST project) based on the specific requirements of the program. A Return on Investment (ROI) analysis was accomplished to determine the potential costs, benefits, and payback period for the LDST based on this concept. Based on cost estimates for the initial development and annual sustainment of the LDST, as well as expected savings in logistics training and support analysis time, we estimated a three to four-year payback period ("breakeven point") to recoup the initial investment in the design, development, and demonstration of the LDST application.

Logistics Decision Support Tool (LDST) Framework and Design Concepts

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GLOSSARY

AFI	Air Force Instruction
AFMC	Air Force Materiel Command
AFPD	Air Force Policy Directive
AFSPC	Air Force Space Command
ASP	Acquisition Strategy Panel
CLS	Contractor Logistics Support
DoD	Department of Defense
EST	Engineering Support Tool
FMS	Foreign Military Sales
IPT	Integrated Product Team
LCCA	Life Cycle Cost Analyzer
LDST	Logistics Decision Support Tool
LOGPARS	Logistics Planning and Requirements System
MAJCOM	Major Command
MNS	Mission Need Statement
NLRA	Network Level of Repair Analysis
OPR	Office of Primary Responsibility
ORD	Operational Requirements Document
PFSA	Post-Fielding Support Analysis Tool
PMD	Program Management Directive
PGM	Product Group Manager
PSM	Performance Supportability Metric
POM	Program Objective Memorandum
PSMP	Product Support Management Plan
SAMP	Single Acquisition Management Plan
SM	Single Manager
SMC	Space and Missile Center
SORAP	Source of Repair Assignment Process
SPD	System Program Director
SPO	System Program Office
SSM	Support System Manager
TSPR	Total System Performance Responsibility
USAF	United States Air Force

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Logistics Decision Support Tool (LDST)
Framework and Design Concepts

1. Introduction

1.1 Purpose

This report documents the results of research activities associated with the development of a framework for the Logistics Decision Support Tool (LDST). The specific research activities conducted as part of this effort included 1) identifying deficiencies and shortfalls associated with current processes used to develop logistics support concepts for space systems; 2) specifying LDST functional requirements to help address these deficiencies and shortfalls; 3) performing a survey of current logistics support tools and software technologies that can be leveraged on to address LDST requirements; 4) estimating a return on investment for LDST; and 5) development of design concepts to demonstrate the core functions of the LDST.

1.2 Background

Previous research and discussions with logistics personnel at HQ AFSPC and SMC personnel have indicated the need for analysis tools that can help logistics managers determine and document the optimal product support strategy for space system acquisitions. The need for such tools is reinforced to some extent by recent guidance provided in AFI 63-107, *Integrated Product Support Planning and Management (Draft)*, which stresses the initial development and continuous assessment of product support strategies throughout the life cycle of a weapon system. According to the AFI 63-107, a key part of the process for developing a product support strategy is a "deliberate evaluation of proposed concepts and practices against legislative, regulatory, and other applicable decision criteria". The quest to define and develop a framework for a decision support tool to support such an evaluation was the departure point for the LDST research effort documented in this report.

1.3 *Introduction*

The principal objectives of Acquisition Logistics are to ensure that support considerations are an integral part of the system's engineering process, that the system can be cost-effectively supported throughout its life-cycle, and that the support resources (products and services) required to support the system are identified, developed, and acquired. To this end, numerous analysis and decision support tools, some redundant in terms of functionality, have been developed to support program offices, particularly logistics managers[1], and acquire support for weapon systems. For instance, there are several DoD, joint, and component developed cost models in existence for deriving weapon system life cycle cost estimates (e.g. LCCA), conducting network level repair analysis (e.g. NRLA) as well as numerous logistics models and analysis tools developed by specific programs to support their own unique tasks and program requirements. While these models and tools can be very helpful to a logistics manager in "automating" the specific analyses and documentation requirements levied on program offices to support acquisition and milestone decisions, none of these models or tools directly support the development of alternative logistics support concepts that ultimately relate program requirements to decisions regarding the specific products and services needed to support the system in the most cost-effective manner possible, over its entire life cycle.

In addition to these tools, there is a myriad of DoD, USAF, MAJCOM directives, policies, and other instructional references available to help logistics managers in acquiring and managing the logistics support products and services required for a weapon system program. For instance, the procedures for developing logistics inputs for an RFP, including defining and tailoring contract deliverables, are fairly well documented in references like MIL- HDBK 502, AFI 10-602, etc. However, the majority guidance documented in these resources is general in nature and primarily speak to "what" a logistics manager needs to address or consider in acquiring the products and services that comprise a support concept.

[1] "Logistics Managers", as referenced in this report, includes personnel responsible for managing and acquiring specific logistics products and services for a weapon system – e.g. technical data.

What none of these tools or references provides is a clear and concise approach to help logistics managers perform a structured, traceable, and integrated supportability analysis that effectively contributes to the development of an optimal product or system support strategy as directed by AFI 63-107. Currently, the process for conducting a supportability analysis has relied primarily on the expertise (through limited training and on-the-job experience) of logistics managers supporting a program office, some of who may be working on their first acquisition program. Hence, a majority of these logistics managers are more generalists, than specialists or "experts" in any particular logistics domain (e.g. Technical Data). The pool of acquisition logistics domain "experts" is dwindling, and this problem will probably become more prevalent in the future based on estimates that almost 50% of the Air Force's acquisition and sustainment workforce become eligible to retire by 2005.

To address this projected loss of acquisition logistics experience, as well as the fact that there is no specific AF career field for acquisition logistics, a need seems to exist for a more "expert-based" decision support tool or application that can help logistics managers, particularly novice managers, conduct a more structured, thorough, traceable supportability analysis – one that is tailored to the specific requirements of their respective programs. This was the premise of the LDST research effort.

1.4 Scope of LDST Research

Due to the scope of the unique requirements of space system acquisition programs, as well as project time and resource constraints, the research conducted as part of this task focused exclusively on defining a framework for a decision support tool that can effectively support Air Force Space Command (AFSPC) logistics managers in conducting a supportability analysis for their respective programs as required by AFI 63-107. More specifically, the LDST framework discussed in this report is intended to help logistics managers in Air Force Space Systems program offices:

- Conduct a structured, logistics supportability analysis that is tailored to their specific program and system requirements.

- Document rationale for addressing key logistics support analysis tasks and decision factors (legislative, DoD, AF, AFSPC, etc.) required by AFI 63-107 that have a direct impact on system supportability and life cycle costs.

1.5 Study Participants and Meetings

Appendix 1 identifies the primary participants in the LDST framework definition and conceptual design effort. A program review was held at SMC, Los Angeles AFB, CA in December 2000 with these personnel to present an overview of the LDST research effort, technical approach, etc. In addition, separate interviews were conducted with key SMC/AXL personnel to become more familiar with the type of logistics support they provide to SMC program offices, as well as to gain additional insight into the types of documentation and other resources they used to perform their jobs. A final review of the LDST research effort, as well as a conceptual demonstration of the proposed LDST framework was presented at AFRL/HESS, Wright-Patterson AFB, OH in August 2001.

2.0 LDST Requirements Definition

2.1 Problem Statement Formulation

The first step in defining the requirements for LDST was to formulate a clear, concise problem statement that could be used as a departure point for developing alternative solutions, identifying enabling technologies, etc. The LDST problem statement, articulated to some extent as part of the scope specified in Section 1.3, was based on a review of a previous LDST development effort, as well as discussions with SMC/AXL and program personnel. The results of this analysis resulted in the formulation of the following problem statement for LDST:

"Space Systems program offices cannot adequately justify and defend logistics support decisions made during the acquisition process to show that the decisions made provide for the delivery of a supportable, sustainable system which achieves the performance, cost, and schedule goals of the program"

The interviews conducted with SMC personnel highlighted some contributing factors to this problem including:

- No specific AF career field for "Acquisition Logistics" personnel. Therefore, program office acquisition logistics responsibilities are typically performed by logistics managers that are more "generalists" than "specialists" per se.
- Personnel new to the Air Force (e.g. directly out of Officer Training School), and personnel from other USAF non-acquisition career fields, are assigned to a program office as logistics managers, responsible for managing the acquisition of multi-million dollar system support resources (e.g. technical data).
- No consistent process or framework for conducting a supportability assessment.
- No decision support tools or applications to support the development of product support concepts.

The problem statement and contributing factors presented above were used to guide subsequent research activities for development of an LDST framework. The problem statement was included as part of an LDST questionnaire (see Appendix 2) and sent to a select group of SMC logistics personnel working in various SMC program offices to support further development and refinement of the LDST framework. Formal responses to the questionnaire were extremely limited. Therefore, a follow-up telecon discussion was conducted with some of these personnel to reiterate the intent of the questionnaire, and solicit feedback on specific questions related to the LDST problem statement, inputs, and outputs. The information acquired from this discussion was used to support the development of the LDST framework.

2.2 Identifying LDST Objectives, Key Capabilities, and Outputs

During the IPR meeting convened at SMC in December 2000, key personnel from HQ AFSPC/LGXR, SMC/AXL, and logistics managers in SMC program offices, participated in a Nominal Group Technique (NGT) session (modified to accommodate the time constraints of the meeting) to help scope the overall objectives and requirements for the LDST effort. The NGT session provided an avenue for rapidly

gathering and ranking ideas that extended beyond the LDST problem statement, to focus more attention on three key components of the LDST requirements definition process. These components included identifying and prioritizing:

- The primary objectives of the LDST
- The key output products of the LDST
- The important capabilities or core functions of the LDST

Due to the time constraints of the NGT session, and availability of personnel, these were the only three topic areas evaluated during the NGT session.

The NGT session provided a forum for participants to have equal opportunity in contributing ideas for each of three LDST requirement topic areas identified above, followed by short discussions to clarify and consolidate inputs as necessary, and finally, allowing each participant to rate the top five ideas generated for each topic area. The rating scheme used to prioritize the ideas submitted by participants was fairly simple. During the rating of each of the three topics, each participant was asked to select what they deemed to be the top five inputs and assign a numeric rating from "1" (least important) to "5" (most important). The numerical ratings assigned by participants were tallied for each response to derive a total score for the same. The synopsis provided below highlights the responses (rank ordered based on points) for each topic question:

Question 1: "What are the primary objectives of the LDST?"

- Provide a common, traceable, acceptable, and reportable process for supportability decisions. A process that ensures all ILS elements are addressed using accepted policy and procedures (30 pts)
- Help acquisition logistics and program managers make cost-effective, support decisions (16 pts)
- Provide the capability to perform what-if analysis (12 pts)
- Support collaboration among stakeholders (11 pts)
- Support for inexperienced logisticians via computer-based training (10 pts)

- Lessons learned database (6 pts)
- Common - Open architecture easy to use (3 pts)
- Provide status of decision activities (1 pt)

The top three inputs listed above represent 67% of the total points generated for this question. The first response seems to clearly indicate the need for a more formal, structured, and rigorous process for determining system support requirements, which aligns with the problem statement defined earlier in the report for LDST.

Question 2: "What are the most important output products of an LDST?"

- Tasks to be performed in each ILS area (19 pts)
- Organic and contractor requirements (15 pts)
- Support the output of decision option reports including associated tasks/cost analysis (15 pts)
- Capture decisions at a "top level". For example, will the system be COTS or developmental? (13 pts)
- Cost data for each ILS element (11 pts)
- Analysis summary (2 pts)
- List of contract Deliverables (2 pts)
- Lessons Learned (1 pt)

The first three inputs represent 63% of the total points assigned to all responses. It is worth noting that the response, "tasks to be performed in each ILS area", is at the very essence of defining a structured process (guided by business rules) for determining system support requirements, particularly for an "expert" based, decision support system. This is a key part of developing a framework for the LDST and formulating LDST design concepts.

Question 3: "What are the key capabilities or functions of an LDST?"

- Support collaboration (20 pts)
- Hyperlink to source/reference documents (10 pts)
- Interface to existing cost models (8 pts)
- Capability to update decision factors (8 pts)
- Configuration management control (6 pts)
- Work on partial data (5 pts)
- Support MS office exchange for e-mail (4 pts)
- Document decisions, comments, etc (4 pts)
- Support a what-if analysis capability (3 pts)
- User Admin module to control level of access, read/write capability, etc. (3 pts)
- Track changes / action items (2 pts)
- Web-based tool or application (2 pts)

The top three inputs listed above represent 61% of the total rating points generated for all inputs to this question. The "support collaboration" response was not completely defined, but in general, means the ability for other stakeholders in the acquisition process (e.g. HQ AFSPC) to actively participate in the acquisition logistics process such as determining and coordinating on support requirements that may become part of an RFP.

2.3 Discussions with SMC Acquisition Logistics Personnel

As stated earlier, separate meetings were conducted with a select group of SMC/AXL personnel with experience in specific ILS areas, to include Maintenance Planning, Technical Data, and Training and Training Systems. The purpose of these meetings was to become generally familiar with the type of support these personnel provide to program offices as logistics managers for each of their respective ILS areas, as well as to gain additional insight on how a decision support tool could help them be more effective in their jobs. It was evident from these discussions there was no structured process, applied consistently across programs, for assessing system

support requirements. In addition, domain specific (e.g. Technical Data) logistics expertise and knowledge is typically accrued over time on a "trial by fire" basis, and the number of resident or staff experts is extremely limited. Hence, an AXL resident "expert" in a logistics area such as Technical Data may be supporting several program offices at one time (source selections, staff assistance support to novice personnel, etc.). This does not mean that a decision support tool like LDST is going to be a panacea for ensuring program offices identify, document (particularly in RFPs), and defend support requirements more effectively and consistently than current practices seem to indicate, but rather, that there is considerable room for improving the process of assessing the logistics support requirements for space systems, particularly since the pool of expertise available to program offices in each ILS area is limited.

2.4 Summary of Key LDST Functional Requirements

Based on the original problem statement developed for the LDST, as well as the information provided through discussions with HQ AFSPC and SMC personnel, including the results from the NGT session, the following "top-level" functional requirements were formulated to support further research and development of the LDST framework and design concepts:

- The LDST should provide an automated capability to support a more structured, traceable process for conducting logistics support analyses that helps ensure key tasks and decision factors impacting system sustainment are addressed.

- The LDST should provide more effective support to novice or in-experienced logisticians responsible for logistics support analyses activities in a program office (reduce reliance on a diminishing pool of ILS domain "experts").

- The LDST should be implemented in a web-based environment to promote more effective collaboration between all program stakeholders (Using Commands, HQ AFSPC, SMC program offices, etc.)

- The LDST should allow logistics managers to document the results of the analysis undertaken in each ILS area to address key tasks and decision factors that contribute to the development of an overall product support strategy.

These initial LDST requirements were used to guide the development of a framework (design concept) for a software application that can help keep logistics managers focused on key logistics decision factors and program requirements that could have a significant impact on system sustainment. For instance, if an ORD requirement stipulates a preference to use contractor support for depot maintenance, that may drive the need to ensure that a program office acquires depot level technical manuals, evaluates alternatives for using contractor or organic depot facilities, etc.

While these two "top-level" functional requirements do not address all the inputs generated from discussions and interviews with SMC and HQ AFSPC personnel, as well as the ideas generated during the NGT session, they do focus on addressing the objective of providing a common, traceable, acceptable, and reportable process for supportability decisions - a process that ensures all ILS elements are addressed using accepted policy and procedures. This was ranked as the number one priority objective for the LDST. Other recommendations from the NGT session, including the capability to perform a cost assessment of support concepts, an "what-if analyses", etc, may become important extensions to an LDST, but do not directly address the LDST problem statement, and were considered beyond the scope of the current LDST research effort.

3.0 Survey of Logistics Decision Support Tools

There are more than 100 separate software tools (some developed as prototypes only) that have been developed over the years to support specific tasks or activities that support the business of acquisition and sustainment logistics. A considerable amount of the LDST research effort was devoted to a literature search and assessment of tools, models, and applications that possessed certain functional or technical characteristics applicable to the LDST requirements outlined above in

Section 2.4. A synopsis of the more relevant tools, models, or applications, applicable to the requirements of LDST follows.

3.1 Logistics Planning and Requirements System (LOGPARS)

Description. LOGPARS is a PC-based, tri-service, expert system for assisting program managers in the preparation of integrated acquisition planning documentation. It is designed to enhance productivity and accuracy in acquisition planning and performance by leading the user through the process of establishing the appropriate acquisition strategy and developing tailored supportability planning and scheduling documentation. LOGPARS is approved by Headquarters Army Materiel Command (HQ AMC) for use in program management offices and is listed in AMC Regulation 700-15. The sponsor of LOGPARS is the USAMC Logistics Support Activity (LOGSA). The primary purpose of the tool is acquisition and supportability planning.

Features. LOGPARS is an expert based system that prompts a user through interactive question and answer sessions to address appropriate issues necessary to automatically generate program documentation. Modules are available to assist in the preparation of the following planning documentation: Acquisition Strategy, Supportability Strategy, Material Fielding Plan, ILS Statement of Work, Provisioning Plan, Transportability Report, Warranty Clause, and Material Fielding Plan.

The LOGPARS software consists of an expert shell (referred to as DOCSHELL), which includes an inference engine, and an integrated knowledge base (KB). The decision rules embedded in a knowledge base to prompt users through the applicable questions they need to address to produce respective program documentation. Using the decision logic in LOGPARS, the knowledge base determines the order and applicability of questions and can even recommend answers. When applicable, LOGPARS issues advisory statements during the preparation of a given document to maintain referential integrity within, and between document modules for a given program. Software programming skills are not required to revise or expand modules that comprise the KB. The KB drives the

LOGPARS expert system and incorporates the experience of Integrated Logistics Support (ILS) planning expertise, lessons learned, and the current acquisition policies/procedures.

LOGPARS runs in a multi-user environment and supports team efforts by allowing other program personnel to participate in the development of program documents. In addition, draft documents can be staffed electronically and reviewers are provided with the capability to input comments on a document.

Applicability to LDST. The expert-based framework used to develop LOGPARS is similar to the approach envisioned for the LDST. Although the intent of the LDST is not to serve as a document generator, it is possible that the process used by LOGSA to develop the decision rules and logic in the LOGPARS KB, particularly for the development of the "Supportability Strategy" document, and possibly some of the decision rules themselves, may be applicable to the LDST effort. It is also possible that the DOCSHELL component, and knowledge development environment used to develop LOGPARS decision rules, could be obtained (without any cost to the government) and used to prototype the development of LDST decision rules.

3.2 Post Fielding Support Analysis (PFSA)

Description. PFSA is another LOGSA product currently under development as part of a tri-service initiative to improve and streamline the ILS process. The overall objective of PFSA is to create an integrated analysis environment that enables the services to be both responsive and proactive in managing logistics support and reducing O&S costs. This includes streamlining the ILS process by providing field units direct access and insight into the product sustainment process (e.g. processing of Engineering Change Proposals – ECPs), and direct contact with logistics support personnel (e.g. item managers). This will allow personnel at the unit level to track the progress of actions related to the reporting of materiel deficiencies, ECPs, etc., as well support continuous, automated monitoring of critical metrics. The

PFSA initiative will utilize existing models and analytical tools, as applicable, as well as existing data sources.

Features. PFSA is being designed to run as a PC-based, client-server application (can also be invoked through a web-interface to act as a "thin" PC client). PFSA contains four distinct modules including 1) a problem-reporting module, 2) an information module, 3) a logistics analysis module, and 4) a reports module. The design plan for PFSA will incorporate a knowledge base, and the use of intelligent agents to source data, monitor and report activity status based on customized user profiles, as well as make specific analysis recommendations ("intelligent analysis") based on the type of reported problem or deficiency.

Applicability to LDST. The logistics analysis module in PFSA includes three sub-modules that could potentially be included as part of an LDST analysis. These modules include a cost-driver analysis, level of repair analysis, and predictive trend analysis that tracks program metrics based on input from an ORD. It is possible that the approach used to develop an "intelligent analysis", as well as components from one or all of these modules may provide some utility in an LDST analysis.

3.3 Engineering Support Tool (EST)

Description. The Engineering Support Tool was developed by SMC/XR to assist logisticians in the developmental planning process by helping ensure system support requirements are addressed in a "systematic" manner early on in a program. It is intended to help logistician's develop and assess alternative support concepts for new technologies that could potentially improve the performance and life-cycle costs of new systems. The EST supports an assessment of pre-defined, qualitative technology "attributes", against "operational suitability" criteria that include: dependability, availability, sustainability, maintainability, producibility, affordability, testability, human factors, and environment.

Features. The EST is implemented in the form of an MS-Excel spreadsheet that supports the inputs of technology attribute ratings and supporting justification, as well as the calculation of an overall "operational suitability" index for each technology.

Applicability to LDST. It is possible that some of the criteria used to further define each technology attribute considered by EST may be applicable to the development of decision rules and "facts" that would comprise an LDST knowledge base.

3.4 LDST Version 1.0 (Prototype)

Description. In 1998, bd Systems Inc. worked with SMC personnel to design and develop a prototype version of LDST that could be used to assist the Air Force Materiel Command acquisition logistics manager, and Air Force Space Command in determining the most appropriate support plan for each space system, or segment, under development. The prototype tool was intended to assist a user by providing a decision logic process that can be documented and supported. The decision logic in the prototype LDST is encapsulated in a decision tree template that steps the user through a series of program and logistics support analysis questions and records user's responses. The LDST logic tree supports a separate assessment of two levels of maintenance: organizational level maintenance, and depot (or factory level) maintenance. The decision tree analysis method is used to evaluate a variety of support alternatives for each level of sustaining maintenance and repair. Each path in the decision tree process may be documented for report generation, as well as for use in comparative analysis with other decision paths as a means to substantiate and justify the recommended decisions.

Features. The prototype version of the LDST developed under this earlier effort is a PC application that provides limited support for the creation and editing of decision support templates used to conduct a logistics support analysis. The prototype version produces two types of output reports. The first report is the "Decision Logic Report", which shows an individual run with the questions and selected answers. This is useful for documenting a decision. It may also be used

within a team to allow others to comment on the process. The second report is the "Comparison Report", which shows the points at which two runs diverge. It does not show the complete runs. This feature is useful in understanding which decision influenced differing outcomes of the process.

Applicability to LDST. To our knowledge, development of the LDST prototype version was not extended beyond this initial effort. However, data and information collected as part of the requirements phase of the prototype effort, particularly some of the ILS element specific decision criteria, and program risk factors could be incorporated (as applicable) as part of the LDST framework developed under this research effort.

3.5 Performance Supportability Metric (PSM)

Description. The PSM is a risk-based management tool developed and delivered by bd Systems Inc. in August 2001 as a replacement to the previous AFMC Command Support Metric (CSM) application. The CSM was intended to help program managers and senior management personnel assess the "health" of supportability for a specific program. The CSM focused almost exclusively on tracking the planning and accomplishment of key program events and activities related to logistics (e.g. Maintenance Concept Approved). The primary shortfall of CSM that is addressed in PSM is program risks. PSM attempts to assess the overall impact and potential risks to a program if an event is not completed on time, or delayed to some future time period.

Features. The PSM tool provides for risk-based "expert" management of program supportability activities and events, and allows logisticians to measure ILS program risks. It also facilitates risk mitigation planning, and allows logistics managers to predict, analyze, manage status, and report on the health of their logistics program.

Applicability to LDST. The PSM is focused on tracking and assessing risks associated with key program events that have a direct impact on logistics. It does not

however, address the matter of helping a logistics manager identify, organize, and document the specific logistics support analysis tasks and decision factors that should be addressed for a particular new system acquisition or modification. In this sense, the LDST could feed PSM inputs on the status and actions taken by logistics managers to address key decision factors and activities throughout a program.

4.0 Potential Technologies Applicable to LDST

Based on the on the baseline requirements specified in Section 2 of this report for development of the LDST framework, a survey and review of applicable software technologies was conducted. This survey focused on software technologies in the artificial intelligence (AI) domain, primarily knowledge-based or expert system software tools that have been developed and applied in various domains to help humans solve complex problems, like those we expect to be confronted with in development of the LDST. Before discussing some of the variant approaches for expert system development, a brief discussion about expert systems is probably in order.

Expert systems are computer programs that simulate the reasoning process and knowledge of human "experts" to solve specific problems (Lee, 1988, Turban, 1990). One of the distinct features of expert systems is that they support the modeling of information at higher levels of abstraction, and are developed in a manner that closely resembles human logic. The goal of most expert systems is to improve organizational efficiency and effectiveness (Ashmore, 1989). For instance, in the case of LDST, the goal for developing an expert system would be to emulate the process that logistics "experts" follow to make decisions about the products and services needed to support a system, so that in-turn, novice logistics managers could perform the same task more efficiently and effectively, while at the same time improving their problem-solving skills. Since expert systems are intended to simulate a human expert, they also have the potential to reduce the time devoted to solving complex problems, while looking at it the problem from a variety of perspectives. Some of the more common applications of expert systems include: strategic goal setting, planning, design, scheduling, monitoring, and diagnostics.

The key components of simplified expert system architecture are depicted in Figure 1. These components include a user interface, knowledge base (KB), and inference engine – which together comprise what can be referred to as a KB development environment. Hence, Figure 1 is intended to convey that these two components are closely integrated and usually comprise the software required to develop expert systems. It is also worth noting from Figure 1 that users do not interface directly with the inference engine of an expert system, but rather through a graphical user interface.

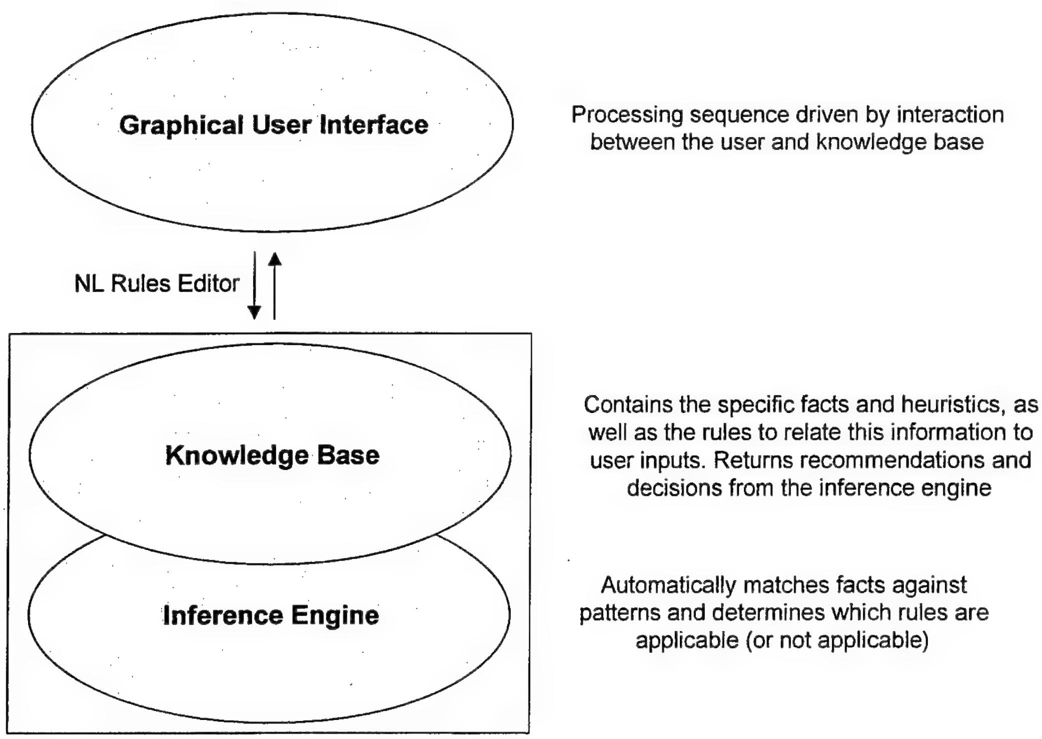

Figure 1. Expert System Basic Architecture – Simplified Representation

The KB is arguably the most important component in an expert system, and probably the most significant challenge in the design and development of any expert system. The KB incorporates the rules, expertise, know-how, procedures, policies and regulations that support an expert system. A majority of the expert system KBs in existence today is implemented using one of three approaches, namely decision

trees, case-based reasoning, and rule-based expert systems. These approaches are summarized below.

4.1 Decision Trees

Decision trees graphically portray a hierarchical set of rules that describe how a person might evaluate or classify an object of interest based on the answers to a series of questions (typically "yes" or "no" questions). The answer provided to each question dictates the branching path taken through the tree that ultimately leads to an end result or decision. Because decision trees are graphical (visual) in nature, they tend to have the advantage of being easy to understand and explain, and can execute decisions processes fairly rapidly. However, one of the primary disadvantages of using a decision tree for knowledge base development is that they maintain a precise logic hierarchy that does not lend itself to being easily modified as questions are added or deleted from the tree. Since a decision tree for LDST could be very large and complex, and highly likely that the decision logic will change from time to time as new knowledge is acquired that impacts the process of developing logistics support concepts (decision factors, risks, policies, and lessons learned), it does not readily seem like the best approach from a software maintenance standpoint for implementing an LDST KB.

4.2 Case-Based Reasoning

For the most part, case-based reasoning (CBR) is synonymous to "reasoning by analogy". The goal of CBR is to solve a current problem by retrieving solutions to historical problems, that are similar in nature, and then modifying those same solutions to derive a solution that addresses the current problem. The historical solutions selected from the knowledge base and used to form the solution to the current problem are typically selected based on some weighting or probabilistic assignment scheme. Hence, CBR is based on the previous experiences of human experts that have years of experience in a particular job and activity. In the case of the LDST, where "expert" level experience in performing jobs like managing the acquisition of system Technical Data is becoming a scarce commodity, CBR could

prove to be a very relevant technique for development of a LDST knowledge base. This could prove to be a distinct advantage for novice logistics managers who could draw on the knowledge of more experienced colleagues, including the knowledge of personnel that are no longer in the organization to readily help them solve their problems. In addition, CBR avoids some of the maintenance pitfalls associated with decision trees, since new questions and answers can be added in incremental fashion to the knowledge base without regard for the problem of ensuring the logical, precise positioning of new questions encountered when using decision trees. Hence, for problem domains where the decision logic is quite extensive and complex, CBR may be a better choice for KB development than decision trees. However, even though CBR avoids some of the pitfalls encountered with the use of decision trees, there is still a considerable amount of human effort and time required to initially develop an extensive "library" of solutions depending on the complexity of the problem domain, and the knowledge must be more rigorously structured than simply a text format.

4.3 Rules-based Programming

Rules-based programming is probably one of the most commonly used techniques for developing KBs for expert systems. This programming technique uses rules to represent heuristics, or "rules of thumb," that specify a specific set of actions to be performed based on the state of events in a given situation. For example, if the doorbell rings, then answer the door. Rules are expressed in an imperative or declarative manner using a combination of "if-then" statements to form a rule. The "if" portion of a rule is a series of patterns which specify the facts (or data) to determine the applicability of a rule. The process of matching facts to patterns is called pattern matching and is handled by the inference engine of the expert system. The "then" portion of a rule is the set of actions to be executed when the conditions of the "if" portion of the rule are satisfied. The applicable actions pertaining to the rule are executed when the inference engine is instructed to begin execution. The inference engine then selects another rule and executes its actions. This process continues until no applicable rules remain.

The rules-based approach is more flexible than a decision-tree approach, but from a software execution standpoint, may require more processing time than a decision-tree or CBR approach if there are numerous rules in the KB, each of which would need to be examined to determine if the facts match the selection criteria encompassed as part of the "if" portion of the decision rule.

4.4 Expert System Software Development Tools

There are several commercial and government software tools available to support the development of expert systems, including the LOGSA DOCSHELL knowledge development environment, discussed in Section 3. A survey of existing expert system development tools is being conducted to determine which tools could potentially support the development of LDST. To date, the following expert system software packages have been identified as potential candidates for LDST:

- ***Savvion Business Manager, Savvion Corp.***

This is a rules-based; expert system development tool that provides the capability to define and capture step-by-step procedures and information flows in a process, as well as the business rules and policies supporting each step in a process. Expert systems developed with this product can be deployed in a LAN/WAN or Internet environment.

- ***Cyc Knowledge Server, Cycorp Corp.***

The "Cyc Knowledge Server" is a large, multi-contextual knowledge base and inference engine used to develop expert systems. It supports natural language processing, and provides the capability to query, browse, and edit information in the knowledge base.

- ***CLIPS***

CLIPS is an expert system tool, which provides a complete environment for the construction or rule-based, and object-based expert systems. It supports three

different programming paradigms for developing expert systems, including rule-based, object oriented, and procedural programming languages (C, Pascal, LISP, Ada). The software is written in the "C" programming language to support fast execution and platform portability. The CLIPS software has supported numerous government and commercial users, including NASA, DoD service components, universities, etc.

- ***JESS (Java Expert System Shell), Sandia National Laboratories***

JESS is an expert system shell written entirely in Java. Jess supports the development of rule-based expert systems, which can be tightly coupled to code written in the powerful, portable Java language. JESS is an interpreter for a rule language borrowed from CLIPS (an idiosyncratic version of LISP), so in general, JESS has evolved into LISP interpreter written in the Java programming language.

5.0 LDST Alternative Design Concepts

Figure 2 provides a conceptual representation of the LDST problem domain, namely the process (inputs, decision and analysis activities, and outputs) used to develop logistics support concepts that encompass all the ILS elements. The "LDST Space" represents the tasks and decision factors that a logistics manager must consider as part of a supportability analysis that is concerned with deriving "optimal" cost-effective support concepts, based on the particular requirements of the program ("LDST Inputs").

As stated earlier in this report, to our knowledge there are currently no automated tools or definitive procedures (step-by-step instructions) that can effectively help a logistics manager conduct a supportability analysis that 1) starts with system and program requirements, 2) assesses these requirements against a set of "acceptable" and applicable acquisition logistics practices and procedures, as well as legislative, DoD, and service policies, etc., and 3) helps define the specific tasks and decision factors that a logistics manager needs to focus on to develop and evaluate support concepts for their respective program.

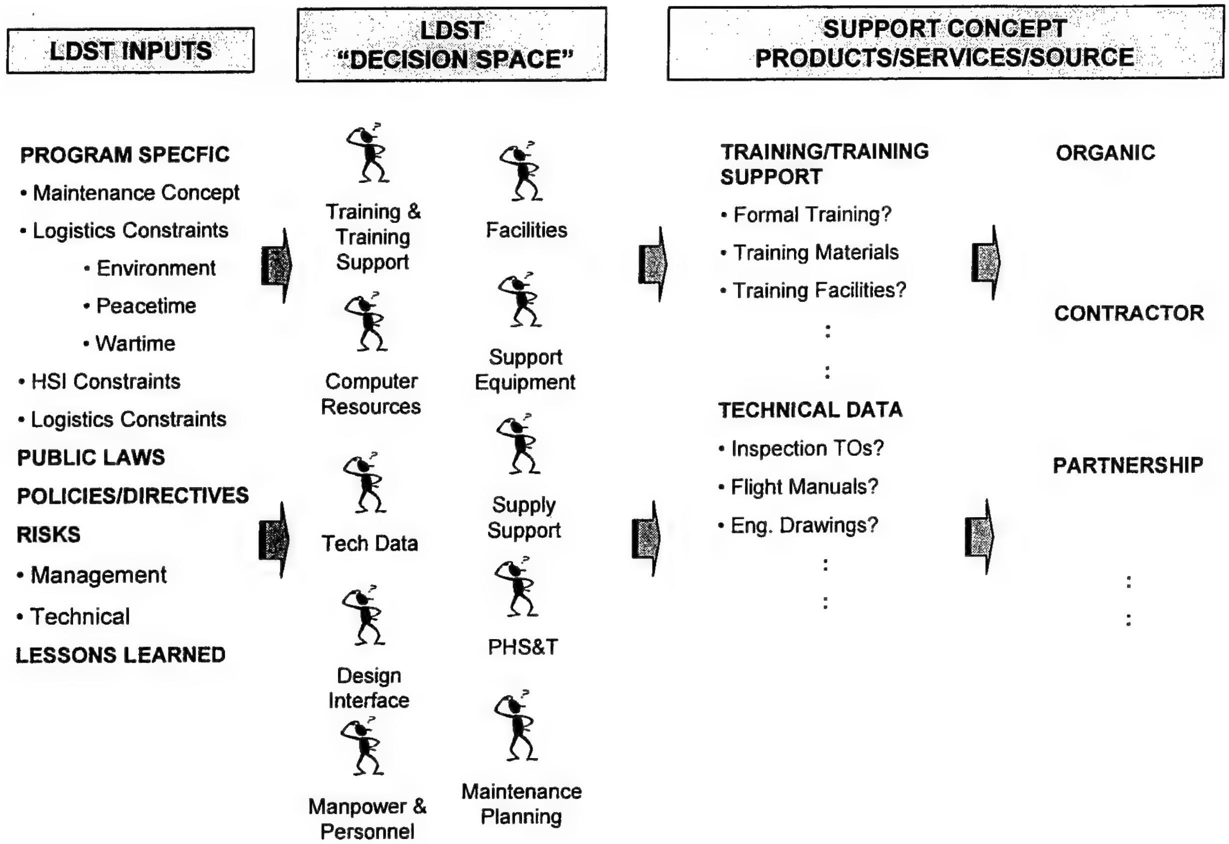

Figure 2. Conceptual Representation of LDST Framework

Based on the research accomplished during the LDST requirements definition phase and discussed above, three alternative design concepts were developed for the LDST. The concepts range from simplistic to complex in terms of the time and level of effort each would take to fully design, develop, and test. The design concepts considered for LDST included the following:

5.1 Concept 1 – Support Analysis Checklist

This checklist concept assumes that the decision process associated with the development of logistics support concepts for each ILS area is "fixed", in essence that the key decision factors and tasks that comprise a supportability analysis are consistent across all acquisition programs. The LDST would output a checklist that displays the key decision factors and tasks that a logistics manager should consider for each ILS area, and support the documentation of the specific status, rationale or

justification provided by a logistics manager in response to each decision factor or task.

Implementing the framework for this design concept would essentially involve two main tasks, namely 1) developing the product/service/source combinations (i.e. the support concepts for each ILS area, and 2) identifying the key tasks and decision factors that are considered by ILS domain "experts" as part of the process of developing and evaluating logistics support concepts.

This is the most basic, and least sophisticated approach for designing and developing the LDST. It does not leverage on the implementation of any advanced software technologies, such as those in the artificial intelligence domain, so the technical risks are considered to be low. It is also probably the quickest concept to implement in terms of software design and development time. This design concept addresses, at a rudimentary level, two fundamental requirements of LDST, namely 1) implementing a structured, traceable, and rigorous process for addressing key decision factors and tasks that comprise a supportability analysis, and 2) providing the capability to document the decision rationale used to address these same decision factors and tasks. The drawback to this concept is that it does not support any automatic, "smart" tailoring of decision factors or tasks in any of the ILS areas, based on the requirements of a specific acquisition program.

5.2 Concept 2 – LDST Support Analysis Project Templates

This concept is an extension of Concept 1 and assumes the decision process associated with the development of logistics support concepts for each ILS area is not "fixed", in essence that the decision factors and tasks considered as part of a supportability analysis are dependent, to some extent, on program and system requirements. This concept would be implemented through an expert-based system design that incorporates "expert knowledge" into the supportability analysis process to help ensure program and system requirements are addressed in a structured and consistent manner. Leveraging the knowledge of logistics domain experts (e.g. Technical Data), the LDST would implement this knowledge in the form of business rules that would be used to automatically generate the applicable task and decision

factor templates that a "novice" logistics manager would need to consider in developing support concepts for their respective program. This approach would help define the "workspace" for logistics managers in order to help them stay focused on addressing only the key tasks and decision factors that are relevant to their respective program. LDST task and decision factor templates would be generated during the initial setup or creation of an LDST project. Once the project was initially created, based on "business rules" in the LDST knowledge base, which would be used to infer relationships between decision factors and tasks, and program and system requirements. Figure 3 provides a summary representation of a CONOPs for the LDST expert system concept.

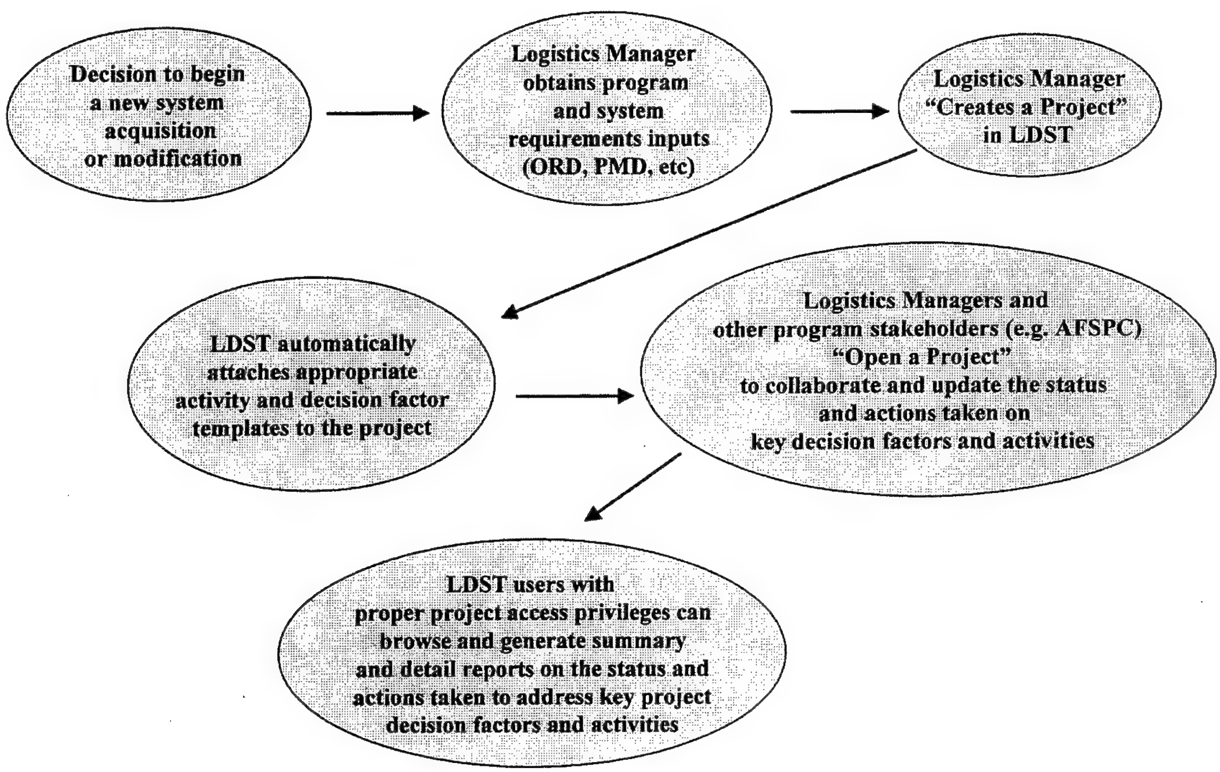

Figure 3. Summary CONOPs for LDST Design Concept #2

The inference engine would support the task of relating program and system requirements to the business rules in the knowledge base to determine the pertinent ILS task and decision factor templates applicable to an LDST project. These appropriate task and decision factor templates would be attached to the project

automatically by the LDST application during the creation of the project. Once created, the logistics manager then opens the project on the server and works inside these templates to record or document the status and actions taken to address the specific task or decision factor identified by the respective template.

The intent of this concept is to try to capture and model the knowledge of an "expert" in terms of a "path" of decision events that ties program and system requirements to specific logistics support analysis tasks and key decision factors. The benefit of this concept is that it gives deliberate attention to the more plausible assertion that "not all acquisition programs are created equally". That in fact, at least some of the key tasks and decision factors considered in the process of formulating a logistics support concept are dependent to some extent on program or system requirements (e.g. type of acquisition program). Appendix 3 includes a table of some of the more important program and system requirements that would be applicable to the LDST.

The benefit of this concept is that it also addresses two very fundamental requirements for LDST, namely 1) implementing a structured, traceable, and rigorous analysis process that keeps logistics managers focused on the key tasks and decision factors that impact their programs; and 2) providing the capability to document the status of tasks and decision rationale.

One of the primary drawbacks to this concept is that the development of an LDST knowledge base, or for that matter most knowledge bases, is that they can require a considerable amount of time and resources to implement, since it is basically a knowledge engineering process, and usually a significant part of any expert system design and development effort. For initial development and demonstration purposes, we would focus on demonstrating the capability for logistics experts to build and modify task and decision factor templates, and for defining the business rules that control the assignment of these templates to a specific LDST project based on program and system requirements.

5.3 Concept 3 – Expert-Based, Support Concept Generator

The final concept is an extension of the LDST expert-based system design encompassed as part of Concept #2. What this approach adds to Concept #2 is the capability to automatically generate alternative support concepts for each ILS element based on program and system requirements input by a user. This could prove to be an extremely powerful feature for LDST, since it would go beyond just generating the key tasks and decision factors that a logistics manager needs to focus on, it would also provide the capability to automatically generate alternative support concepts based on program and system requirements. The benefits of this concept include those specified for Concept #2, as well as the ability to extend the utility of LDST to accommodate the analysis and generation of support concepts when complete information about program and system requirements is not available, primarily starting during the concept exploration phase of a program. One of the primary drawbacks to this concept is that the development of an LDST knowledge base becomes a more complex undertaking, since we are now trying to develop the capability for the LDST knowledge base and inference engine to "extrapolate" from what is known, to accommodate situations early on in a program when we need to develop and assess alternative support concepts. In this case, the LDST could help a novice logistics manager assess what alternative support concepts should be considered and analyzed further, based on what the user knows about the program, and eliminate those concepts that may not be feasible or applicable based on current program requirements and/or knowledge acquired by "experts" from experience with previous acquisition programs.

6.0 Proposed Solution

The three alternative design concepts discussed above were evaluated against each key LDST functional requirement specified in Section 2.4. Based on this evaluation, Concept #2, *"LDST Support Analysis Project Templates"* was determined to be the most suitable concept for design and development of a LDST application. This concept was embellished further to include a definition of the core

functions (main modules) of the LDST, a LDST system architecture, and finally the development of a conceptual, "walk-through" demonstration using MS PowerPoint.

6.1 Main Application Modules

The LDST would be implemented, as a web-based application comprised of the main modules portrayed in Figure 4. LDST users would login to the LDST application and, depending on the authorizations specified in their user profile (setup by a system administrator), they would be allowed access to one or more of the LDST modules. There are three classes of users envisioned for the LDST including a logistics manager that is responsible for creating and updating task and decision factor templates for their respective LDST projects; logistics domain "experts" that create and maintain LDST task, decision factor, and program requirement templates and business rules for applying the templates to LDST projects; and finally, "general" LDST users that require only limited read/write capabilities to one or more projects in the LDST project database. This class of "general" users would include personnel at

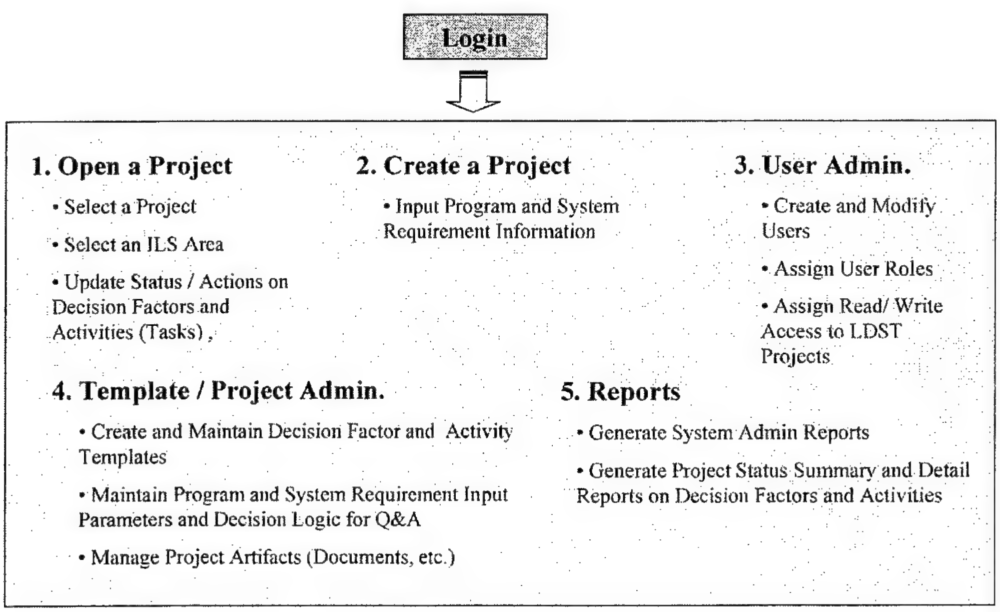

Figure 4. LDST Main Application Modules

AFSPC, SMC, AFMC, user locations, etc. These are stakeholders or participants in the acquisition process, but are not directly assigned as logistics managers to a specific program office, nor "experts" in any specific logistics domain. The primary features of each LDST main module are also specified in Figure 4.

6.2 LDST System Architecture

Figure 5 depicts the overall system architecture envisioned for the LDST application. As stated previously, the LDST application would be accessed through a web-based browser utilizing HTTP protocols. Java Server Pages (JSP) would be "served up" from a web server to the user to support the input of data, template display and output reports. The LDST database would include the templates developed by "experts" as well as to store LDST projects and project related information and documents (e.g. ORD). The key feature of this architecture is the

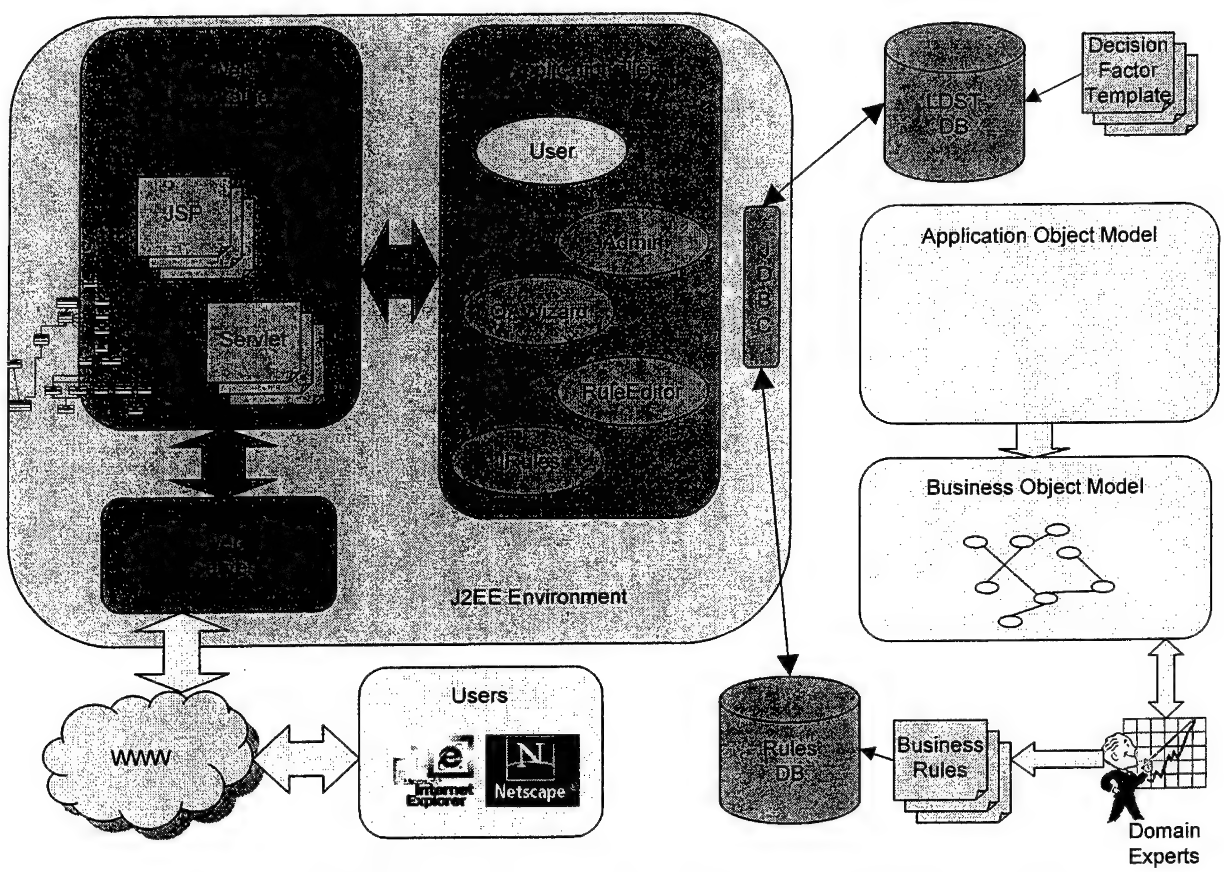

Figure 5. LDST Expert-Based, Proposed System Architecture

separation of business logic from the application logic that would support the creation and modification of business rules that control the application of the LDST templates to specific projects using a product such as the ILOG Incorporated, J-Rules software component. This component allows "experts" to update business rules that are based on acquisition policies and directives, which could potentially change over time. This helps to reduce software sustainment and modifications costs associated with the need for software programmers to change "hard-coded" business rules or programming logic that are usually embedded as an intrinsic part of a software application. This is considered one of the primary technical benefits of the expert-based design concept for the LDST application.

7.0 LDST Return on Investment Analysis

A simplified Return on Investment (ROI) analysis was undertaken to assess the expected costs and benefits of LDST. The cost component of the ROI analysis was comprised of estimates for the initial development (software design, development, testing, and documentation) of the LDST application based on the features discussed in Section 5 for Concept #2 (expert-based system utilizing support analysis templates) as well as the projected sustainment costs. The estimated total cost of the initial LDST development effort is $500,000, with a period of performance of 18 months. The annual maintenance costs were estimated to be $50K per year with a 4% escalation factor built-in each year to account for increases in labor costs, etc.

The benefit component of the LDST ROI analysis focused on developing quantitative cost savings for two key benefit sub-components (or categories) – reduced acquisition logistics training costs, and reduced time associated with conducting logistics support analysis activities in a program office. Table 1 provides a summary of the specific cost factors used to derive an annualized cost savings at SMC for the LDST. The values for "Estimated Time Reduction" were provided by SMC/AXLX personnel based on current and historical experience with acquisition training and the time expended by logistics managers in program offices performing acquisition logistics support activities. For simplicity, military personnel costs were

based on salary factors provided in AFI 65-103 (FY 2001 rates) for a Captain (O-3), and GS-13 Civilian.

Category	Estimated Time Reduction	Current Time Months	Estimated Number Personnel	Estimated Time Savings (Months)	Savings (Capt) Mil	Savings (GS-13) Civ	Annual Total
Training	30%	12	10	36	$257,097	0	$257,097
Acquisition Logistics Support	25%	12	0	3	$42,850	$88,525	$131,375
Total							$388,472

Table 1. Parameters Used to Derive LDST Annual Cost Savings

The LDST cost savings for "Training" are based on an estimated 30% reduction in the time devoted to initial acquisition logistics courses required to obtain Level II, Acquisition Logistics Certification, which on the average, takes about one year to complete. Based on guidance from SMC/AXLX, it was estimated that 12 military (no civilian) personnel are involved in Acquisition Logistics training in a typical year. Using the 30% training time reduction factor, and other parameters cited in Table 1 for "Training", the baseline annual cost savings is approximately $257,000 per year.

The LDST cost savings for "Acquisition Logistics Support" in Table 1 are based on an estimated 25% reduction in the time devoted by SMC logistics managers to analyzing and documenting logistics support requirements for their respective programs. This also includes the time expended by SMC/AXLX staff "experts" who provide specialized support in one or more of the ILS functional domains (e.g. Technical Data, Maintenance Planning, Training Systems, etc.) to logistics managers in one or more SMC program offices. SMC/AXLX estimated that through the use of the LDST, logistics managers could reduce the overall total time expended to the analysis and documentation of support requirements (during EMD) by 25% or from one year to nine months. SMC/AXLX also projected that it had an average of six programs (including major modifications) in the EMD phase at any given time. For simplicity, it was assumed that four of the six programs ongoing at

any given time at SMC are supported by four civilian (GS-13), and two military (Captain) logistics managers. Using these parameters, as well as the salary factors cited earlier, the estimated, annual cost savings (baseline) for LDST is approximately $388,500. An annual 3% cost of living increase was applied to this figure to project out-year costs.

Figure 6 portrays a ten-year cost-benefit analysis that compares the annual estimates for LDST software development and maintenance to projected LDST cost savings estimates. Based on starting LDST development in FY02, the projected "break-even" point would occur towards the end of FY05; at which point the initial development costs for LDST would be recouped.

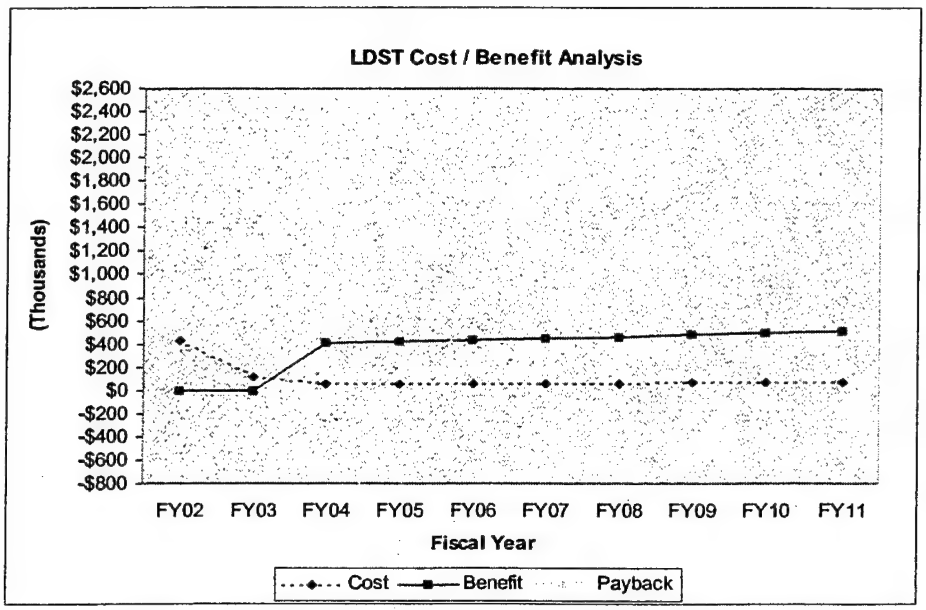

Figure 6. LDST Cost-Benefit Analysis Summary

8.0 Conclusion

The LDST research focused on defining and developing a framework for a decision support tool that can help acquisition logistics managers perform a more structured, focused, and rigorous supportability analysis for space systems programs. The proposed LDST design concept will address this need by leveraging advances in both web-based and expert system software technologies, as well as the limited pool

of logistics domain expertise, to provide a decision support application that emphasizes the active, versus passive, management of "expert" knowledge that can help novice logistics managers focus on addressing critical support analysis tasks and decision factors that can significantly impact the sustainment of space systems. The LDST design concept proposed in this report will:

- Improve the process for conducting logistics support analysis early on and throughout the life-cycle program by providing a structured approach for addressing and documenting the logistics support analysis decisions and tasks.
- Ensure that logistics support analysis tasks and decision factors are addressed in a more structured and consistent manner, thereby reducing the workload and training requirements for logistics managers.
- Address the need to capture, and build-on critical corporate knowledge from logistics "experts" who will be leaving the workforce in the near future by providing a mechanism for capturing and retaining corporate knowledge embodied by a limited pool of acquisition logistics "experts" in a readily maintainable format.

It is worth noting that during the LDST research effort, HQ AFSPC/LGXR representatives identified the need to be able to conduct a low-level of fidelity, sustainability and affordability analysis for programs early on in a program. This type of analysis would focus on expanding the functionality of the proposed LDST design concept outlined in this report to help staff personnel at HQ AFSPC develop an initial set of logistics requirements that would be documented in an ORD, and precede the analysis of logistics support requirements at SMC. The intent would be to determine cost, readiness, and performance impacts of supportability decisions early-on in a new program (or major modification) before these same decisions are translated to program requirements that subsequently get specified as part of an ORD or other program requirements document. In this case, the LDST could be expanded to include a structured, consistent, rigorous logistics requirements definition process that could be used by HQ AFSPC personnel and ensure the right requirements are addressed in the acquisition process, particularly in the specification of contract deliverables that have a direct impact on the long term sustainment costs and performance of space systems.

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Appendix 1. LDST Key Points of Contact

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* Project Manager

Appendix 2. LDST Questionnaire

Requirements Definition

Problem Definition and Scope

Please address each of the following statements and questions regarding the LDST. The statements and questions in this first iteration are intended to help reach a consensus among the members of the LDST focus group on the following:

- Formulating a clear, concise problem definition for the LDST.
- Scoping the focus of the problem to aid in defining the functional and technical requirements for the LDST.
- Identifying contributing factors to the LDST problem that will serve to help better define LDST goals, guide the remainder of work in the requirements definition process (Note: Some of these factors could be translated directly into goals or requirements for the LDST).

REMARKS" ARE STRONGLY ENCOURAGED FOR ALL QUESTIONS/STATEMENTS

- **LDST Problem Definition**

Space Systems program offices cannot adequately justify and defend logistics support decisions made during the acquisition process to show that the decisions made provide for the delivery of a supportable, sustainable system which achieves the performance, cost, and schedule goals of the program.

Note: "Logistics support decisions" as identified in the problem statement above refers to the concept or strategy (organic, contractor, mix of organic and contractor, TSPR) proposed by the SPO for supporting both on and off-equipment maintenance requirements at the organizational and/or depot level.

Agree Disagree Neither Agree/Disagree

Remarks:

- **Assumptions**

1. In order to expedite the development of design concepts for LDST, the initial focus of the LDST will be on supporting the development of logistics support concepts or strategies derived during the system acquisition process, starting with a Milestone 0 decision to enter the Concept Exploration phase, and ending with a Milestone III decision to enter Production, Fielding/Deployment, Operational Support.

Agree Disagree Neither Agree/Disagree

Remarks:

2. In order to expedite the development of design concepts for LDST, the initial focus of an LDST requirements analysis should address the development of logistics support concepts or strategies for the ground segment of a space system.

Agree Disagree Neither Agree/Disagree

Remarks:

3. The primary users of the LDST would be Acquisition Logistics Managers (LMs) in space system program offices (SPOs), or other Acquisition Logistics staff personnel responsible for developing logistics support concepts or strategies.

Agree Disagree Neither Agree/Disagree

Remarks:

4. A baseline process for developing a logistics support concept or strategy that addresses key decision criteria/issues, includes source data including inputs (e.g. program requirements, legislative requirements, policy and directives, and other decision factors), activities (e.g. the questions or issues that must be addressed); and outputs (products of an activity), can be clearly defined.

Agree Disagree Neither Agree/Disagree

Remarks:

5. The final output of the LDST process is the recommended support concept or strategy for a space system segment?

Agree Disagree Neither Agree/Disagree

Remarks:

- **LDST Problem Definition - Contributing Factors**

The following set of statements is an attempt to identify contributing factors to the LDST problem (as defined above) that prevent a SPO from adequately justifying and defending logistics support decisions. These factors (once embellished or expanded) will help form the baseline for defining specific goals for the LDST.

1. No feasible capability exists to clearly show or trace the specific steps or activities accomplished during the logistics support planning process.

Agree Disagree Neither Agree/Disagree

Remarks:

2. No feasible capability exists to document the specific rationale used at each key decision point in the logistics support planning process.

Agree Disagree Neither Agree/Disagree

Remarks:

3. No feasible capability exists to delineate all the decision factors in a program that should be considered (by policy, directive, etc.) in the logistics support planning process.

Agree Disagree Neither Agree/Disagree

Remarks:

4. No feasible capability to bring all stakeholders (to include users, AFSPC, sustainment logistics personnel, contractors, etc.) into the process early-on in a program to collaborate and provide inputs to decisions made in the logistics support planning process.

Agree Disagree Neither Agree/Disagree

Remarks:

5. The frequency of personnel turnover (due to retirements, force reductions, PCS actions, etc.) into and out of LM or acquisition logistic positions responsible for logistics support planning significantly impacts (negative) the process.

Agree Disagree Neither Agree/Disagree

Remarks:

6. The skill level or experience level of LMs or acquisition logistic personnel responsible for logistics support planning can significantly impact the decisions made during the logistics support planning process.

Agree Disagree Neither Agree/Disagree

Remarks:

- **General Questions**

1. In developing a logistics support concept or strategy, does the decision process (in terms of activities, inputs, outputs) differ by the type of space system under study or development? Yes No

Remarks:

2. In developing a logistics support concept or strategy; does the decision process (in terms of activities, inputs, outputs) differ by the type of space system segment (ground, launch, or space) under study or development? Yes No

Remarks:

3. Assuming we can define a baseline process for the logistics support planning process, can we further define a discrete set of business rules that could be used to help tailor the baseline process for "unique" acquisition programs? Yes No

Remarks:

4. What do you feel are some of the key benefits of an LDST that can address the factors identified above (e.g. reduce the acquisition cycle time, improve continuity in the logistics support planning process, reduce training time for LM s, reduce life cycle costs, etc.)?

5. Should the LDST target "expert" or "novice" Acquisition LMs, or both?

6. In your opinion, will it be possible to define the characteristics of an "expert" and "novice" LM or Acquisition Logistic user for LDST? Yes No

Remarks:

7. In your opinion, are ALL the <u>relevant</u> data / information sources available for developing inputs (decision criteria / factors, etc.) for a LDST? Yes No

Remarks:

8. Identify some of the more relevant references (e.g. legislative directives, policies, etc.) a LM needs to consider in developing a logistics support strategy.

9. What, if any, <u>relevant</u> data / information sources do you feel are <u>not</u> readily available for developing inputs (decision criteria / factors, etc.) for a LDST?

Appendix 3. LDST Data Requirements

The data elements identified below represent a subset of the program and system data elements that would be used from program documents such as the Operational Requirements Document (ORD), Mission Need Statement (MNS), Program Management Directive (PMD), Acquisition Strategy Plan (ASP), etc. to create a LDST project. Logistics domain "experts" would use these data elements to construct decision (business) rules that would be applied in LDST to control the assignment of task and decision factor templates to LDST projects.

Data Element	Sources	Remarks
Program Title	ORD Title	
Type Acquisition	PMD/ASP	
Type System	ORD	
Number of Systems	PMD	
Type Missions	ORD, Section 1	
Maintenance Concept	ORD, Section 1	
Levels of Maintenance	ORD, Section 5a	Organizational, Intermediate, Depot
Type Maintenance Tasks	ORD, Section 5a	Remove and Replace, etc.
Expected Operational Life	ORD	
Provisioning Strategy	ORD, Section 5f	
Special PHS&T Considerations	ORD, Section 5f	
Support Equipment	ORD, Section 5b	
System Description	ORD, Section 1	
Training Concept	ORD, Section 5e	
Transportation and Basing	ORD, Section 5g	
Mission Capable Rate – Objective	ORD, Section 4c	MC Rate (Objective) – Peacetime MC Rate (Objective) - Wartime
Mission Capable Rate – Threshold	ORD, Section 4c	MC Rate (Threshold) – Peacetime MC Rate (Threshold) – Wartime
MTBM – Scheduled – Objective	ORD, Section 4c	MTBM Scheduled (Objective) – Peacetime MTBM Scheduled (Objective) - Wartime
MTBM – Scheduled – Threshold	ORD, Section 4c	MTBM Scheduled (Threshold) – Peacetime MTBM Scheduled (Threshold) - Wartime
MTTR – Scheduled Objective	ORD, Section 4c	MTTR Scheduled (Objective) – Peacetime MTTR Scheduled (Objective) - Wartime
MTTR – Scheduled Threshold	ORD, Section 4c	MTTR Scheduled (Threshold) – Peacetime MTTR Scheduled (Threshold) - Wartime
Operational Availability Objective	ORD, Section 4c	A_O Peacetime (Objective) A_O Wartime (Objective)
Operational Availability – Threshold	ORD, Section 4c	A_O Threshold - Peacetime A_O Threshold - Wartime
Human Factors and Performance Requirements	ORD, Section 5e	
Manpower Constraints	ORD, Section 5e	
Missions	ORD, Section 1	

Data Element	Sources	Remarks
Unique Data Requirements	ORD, Section 5f	
Unique Infrastructure and Environmental Compliance Requirements	ORD, Section 5f	
Logistics Support Constraints	MNS, Section 5	

Note 1: ORD reference is CJCSI 3170.01A, Appendix A, Enclosure E, 10 Aug 1999
Note 2: MNS reference is AFI 10-602, Attachment 5
Note 3: PMD reference is HQ USAF Operating Instruction 800-2